

**DEVELOPMENT AND IMPLEMENTATION OF JOINT PROGRAMS IN LASER RANGING AND
OTHER SPACE GEODETIC TECHNIQUES**

Contract NAS5-01113

Quarterly Report 13

For the Period: 1 July 2004 through 30 September 2004

**Principal Investigator
Dr. Michael R. Pearlman**

September 2004

Prepared for

**National Aeronautics and Space Administration
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QUARTERLY REPORT

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Principal Investigator: Dr. Michael R. Pearlman

Pearlman continued to work at a reduced level during this reporting period to accommodate the FY2004 budget constraints at NASA.

International Programs

Although Pearlman is on the Directing Board of both APSG and WEGENER, he was not able to attend the APSG Meeting in Singapore in July 2004 and the WEGENER Meeting in Tangiers, Morocco in September 2004 due to limited travel funds.

Arabian Peninsula Programs

The SLR operation in Riyadh continues at an impressive level under the direction of John Gilfoyle. The station tracked nearly 6000 passes last year with sub-cm precision, making it one of the top-performing systems in the network. Data typically arrives at the CDDIS within a few hours of acquisition and is routinely used by the international scientific community.

With NASA and NSF funding, four GPS receivers are working in Saudi Arabia as part of a joint Saudi-US program through MIT to measure the dynamics of the Arabian Peninsula. The US provided the equipment and the Saudis provided most of the infrastructure. (These four stations will be used in conjunction with other GPS stations to be located in country by the Saudis.) Under this program, two of the US furnished GPS receivers have been operational for about a year: one on the north coast of the Red Sea (just below the Jordanian border) and one on the south coast of the Red Sea just north of the border with Yemen. These receivers are taking data. The other two US furnished receivers were placed in Riyadh (at the SALRO site) and at Jeddah (along the central Red Sea coastline).

Fourteenth International Workshop on Laser Ranging

Pearlman and Carey Noll worked with the Real Instituto y Observatorio de la Armada (RAO) to organize the Proceedings for the Fourteenth International Workshop on Laser Ranging held in San Fernando, Spain, June 7 - 11, 2004. Papers are due at the end of September. The abstracts of the papers are posted on line at: <http://www.roa.es/14workshop-laser/>. The plan is to have the proceedings completed by 31 December, to be issued on both CD and hard copy.

Our paper on "Solar System Dynamics and Tests of General Relativity with Planetary Laser Ranging" is near completion.

International Laser Ranging Service

Working Groups

During this reporting period, Pearlman participated in the activities of all of the ILRS Working Groups.

Analysis

Letters were written to ASI and DGFI congratulating them on their selection as the ILRS Official Combination Center and Backup Center respectively. The next meeting of the AWG will likely be held at A.G.U. in San Francisco in December.

Network and Engineering

A study activity has been initiated by the Central Bureau to validate the techniques being used at the stations for the computations of normal points. The working group has also begun activities on the new engineering database.

Missions

Discussions are underway on procedures to safeguard laser vulnerable detectors aboard satellites. A procedure with rather complex safety measures has been drafted, but the active mechanisms may prove hard to implement. JAXA has also proposed wording for liability agreement for ALOS which could be model for other satellites.

Signal Processing

The WG continues to work on the signal strength modeling for range corrections on the spherical satellites. Graham Appleby and Mike Pearlman also met with Dave Arnold to discuss some of the more complicated issues with mm range corrections. Dave is willing to work at a very modest price if funding can be found.

Data Formats and Procedure

The Refraction Study Group will work with the CB to put the new refraction model on the website. The WG will make a recommendation that the analysis groups adopt the new model when appropriate. NSGF has developed a web page that tabulates the time biases for all of the predictions for all of the predictions. Both the stations and the prediction providers have been urged to check and compare. Redundancy is good, but in some cases we have more providers that we need. Missions have been urged to take responsibility for their own predictions.

Governing Board

SLR data users have been once again urged to acknowledge the ILRS in their publications. Measures are underway to express data volume in passes and minutes of data rather than the current pass segments. EDC has discovered the problem that has hindered their data QC processing and should be remedying it momentarily. The ILRS Terms of Reference have been updated as prescribed in Nice, including (1) the new IAG change in structure, (2) the reduction from two GA meetings per year to one meeting, and (3) the new

means of selecting the ILRS Alternate for the IERS Board.

The writing of the ILRS Report for 2003/4 is underway. Election of the next ILRS Governing Board is nearly complete. The Board will schedule its next meeting at AGU.

Mark Torrence has taken over the responsibility for issuing the quarterly report cards. The Second Quarter Report has been issued.

Pearlman conducted the monthly Central Bureau meetings during this reporting period; ILRS action items were issued and monitored.

Network

As a result of the recent NASA budget reductions, the SLR stations in Arequipa and Maui have been closed and cutbacks have been implemented at GSFC, Monument Peak, and McDonald. Efforts are now underway to bring the Arequipa and Maui stations back into operation.

The Station Qualification procedure has been implemented. ILRS maps now highlight the operational stations. GPS receivers are now at all of the high performing stations. Some are still awaiting IGS endorsement.

Ground Survey and Collocations

The IERS has established Working Group 2 on Site Survey and Collocation. From the ILRS, Mike Pearlman, Giuseppe Bianco, and John Manning are members. The WG has the task of coordinating collocation survey activities at the multi-technique stations. At its first meeting in Nice in April, the WG agreed to (1) develop a survey standards document to provide details, explanations, and examples of full site survey reports, (2) draft a brief explanation for the need of precise terrestrial ties, (3) establish an IERS WG2 web site to collate all existing site survey reports, and (4) clearly define output products including a detailed explanation of the SINEX requirements.

HTSI is also in the process of analyzing the recent survey data from several other stations.

Data Centers

The CDDIS and the EDC have come to agreement on a revised structure to archive the SLR data. When implemented, this will end some historic differences in the data files at the two centers. The new data structure has been endorsed by the Analysis WG with the caveat that on-line monthly data files are built up continuously rather than being issued at the end of each month. The Data Centers have also agreed to a 5-minute turnaround time for data availability.

Mission Items:

ALOS: A Tracking Support Request Form was submitted by JAXA for the ALOS satellite, which is scheduled for launch in September 2004. This satellite carries a very sensitive optical detector that sweeps the ground normal to the satellite groundpath. The SLR tracking could damage the detector, and a very careful safety plan must be implemented. The mission will start off with a few very carefully monitored stations and expand coverage as confidence increases. The GB was very concerned with the liability issue and was

reluctant to proceed without some sufficient indemnity for detector damage.

ICESat: ICESat is being routinely tracked with a limited number of carefully monitored stations.

GP-B: The GP-B mission issues weekly viewing tables. HTSI is providing predictions. Data volume has been variable, due mainly to the turning on and off of the drag compensation.

Galileo: We are still waiting for more information from ESA system engineers on the technical details of the retroreflector arrays.

Meetings

The GB will plans to hold its next meeting at the AGU in San Francisco in December. Graz has offered to host a small working group meeting on kHz lasers later this year. NSGF will host the ILRS Meetings in the fall of 2005.

Interservice Activities

GGOS

Pearlman is the organizer of the Networks and Infrastructure Working Group in GGOS. The role of the Organizer was to get the process going and to help find a permanent chair. Few were naive enough to think it would stop there. The WG needs to develop a charter, a membership, and a work plan. DGFI will begin work on a GGOS website and will provide the GGOS Secretariat.

The key GGOS participants will meet next at AGU in San Francisco in December. The Working Groups will develop and circulate their material.

Draft elements for a working plan include:

1. Take stock of all station information, set it to a standard format including local survey and collocation data, integrate it and provide it in a user friendly web format;
2. Take stock of all data bases and make them available in an integrated basis in a user friendly web format;
3. Document the system and network upgrade plans for the space geodetic techniques (VLBI 2010 vision, SLR2000, etc.);
4. Using the latest version of the analysis packages, test the sensitivity of key geodetic parameters and data products to network configurations and capability;
5. Ascertain what our minimum requirement will be for the stability of the reference systems and other key products (e.g. How well do we want to measure surface?)
6. Start to design networks to satisfy the requirements in item 5.
7. Start thinking about a controlled transition based on the current network constraints and the activities planned (what else is needed?).

Pearlman will draft up a charter and a plan to get started for review.

IERS Working Group on Survey and Collocation

Pearlman is a member of the IERS Working Group on Collocation and Site Survey. WG members have agreed to undertake a Pilot Project (PP) in site survey and co-location. John Dawson, the Working Group Chair has developed and circulated a charter. A Draft Survey Standards Document, with more details and a full site survey report example is also being prepared. Angermann, Altamimi, and Rothacher will rework the explanation for the need of precise terrestrial ties.

Dawson and Richter will establish an IERS WG2 web site with links to the template survey documents and example survey reports. The Working Group will also collate all existing site survey reports on the web site. Angermann and Rothacher will provide a document on the output products including a detailed explanation of the SINEX products.

INDIGO

Funds for the INDIGO activity has been received by GSFC and JPL. The funds from NASA support a four-year effort by the IVS, IGS, and ILRS to integrate the VLBI, GPS, and ILRS data and information bases and make them user friendly. The project was viewed as the NASA contribution to this effort, to be implemented by the Central Bureaus and the Data Centers with strong liaison and cooperation with the international community. Discussions are underway on the best means of implementation.

NGO

Pearlman is working with people from GSFC, JPL, and the University of Texas to develop a plan for the NASA Global Geodetic Observatories. The plan will encompass a network of stations with collocated geodetic techniques to provide the basis for the fundamental reference system at the mm level for long term measurements. The progress on the plan will be presented to NASA HQ at the FAR review in early November. It is anticipated that this will link closely with the GGOS activity and the INDIGO activities above.

Support for the NASA Network

Pearlman continued to provide technical and operational support and overview for NASA in the field of laser ranging, including system performance evaluation, system diagnosis, and system engineering, and provided technical support to the HTSI engineering and software staff.

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